ECEN 250 Lab6 - Sinusoidal Steady-State

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Purposes:

- Observe sinusoidal steady-state behaviors of capacitors and inductors through simulation.
- Understand the meaning of "sinusoidal steady-state".
- Use lab equipment to evaluate sinusoidal steady-state behavior of RLC circuits.

Procedure:

<u>Part 1a - SPICE simulation of an RLC series circuit with a sine wave source</u>

Simulate the following circuit in LTspice:

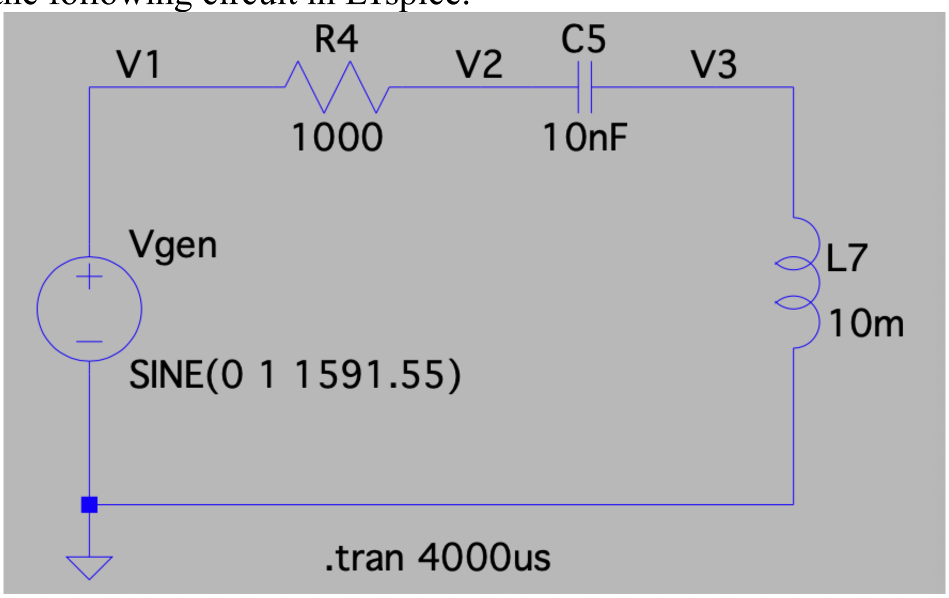


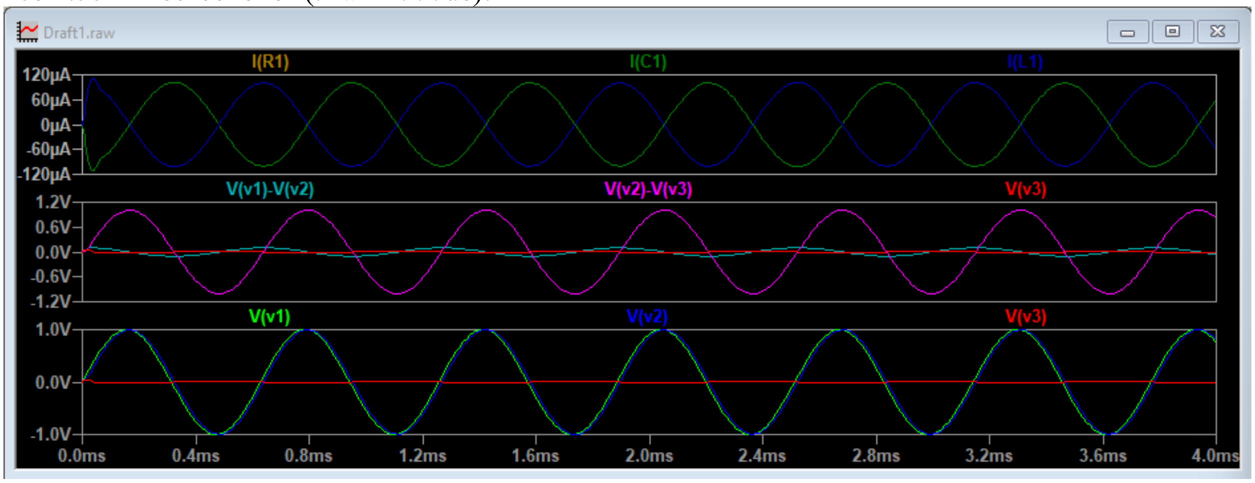
Figure 1a - A Series RLC SPICE Circuit with a Sine Wave Source

Calculate the following reactances and impedances for the schematic 1a component values:

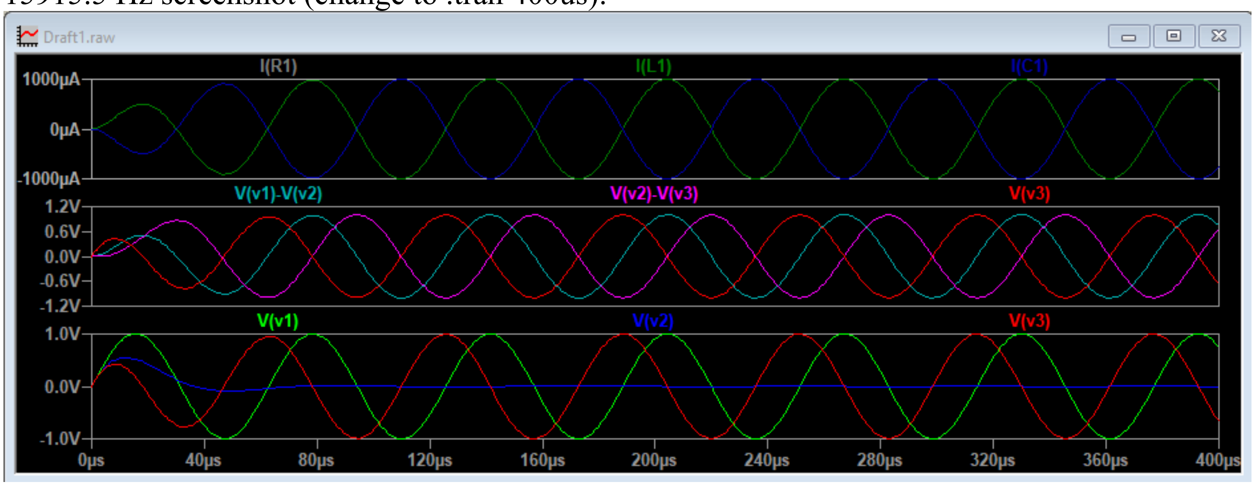
Frequency	R	X_L	X_C	X_{total} (Series X_C & X_L)	Z_{total}
1591.55 Hz	1k	100	-10k	-9.9k	1k - j9.9k
15915.5 Hz	1k	1k	-1k	0	1k
159155 Hz	1k	10k	-100	9.9k	1k + j9.9k

Place screenshots of the simulation results of the 3 frequencies indicated in the table. In each simulation, display V(v1), V(v2), V(v3) in one plot pane, and V(v1)-V(v2), V(v2)-V(v3), V(v3) in a second plot pane, and I(R4), I(C5), I(L7) in a third plot pane. Note that the second plot pane is just the voltage drops across each component.

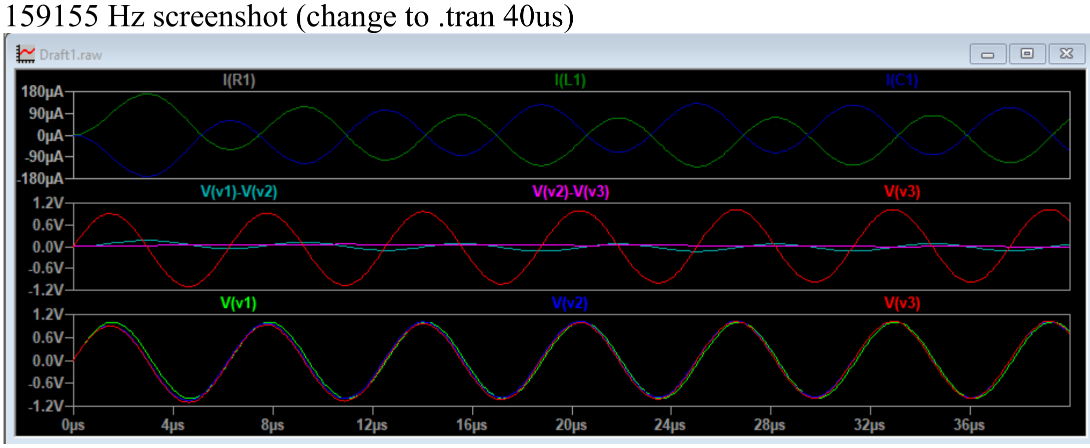
1591.55 Hz screenshot (.tran 4000us):



15915.5 Hz screenshot (change to .tran 400us):



159155 Hz screenshot (change to .tran 40us)



Section Summary

Can you make sense of these voltage and current waveforms based on the calculated reactances (explain)?

If reactance changes, the voltage and current will have to change because reactance can be compared to resistance in ohms law. High reactance = lower current and higher voltage while lower reactance = higher current and lower voltage. With a positive reactance, the capacitor current is 0 and while its negative the inductor current is 0.

At what approximate point in time would you say the 15915.5 Hz signal reaches "steady-state"?

About 0.1ms

Part 1b - SPICE simulation of a parallel RLC circuit with a sine wave source

Simulate the following circuit in LTspice:

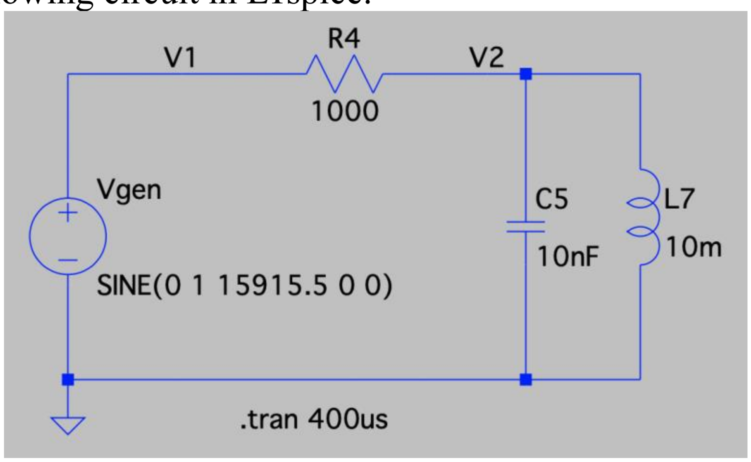


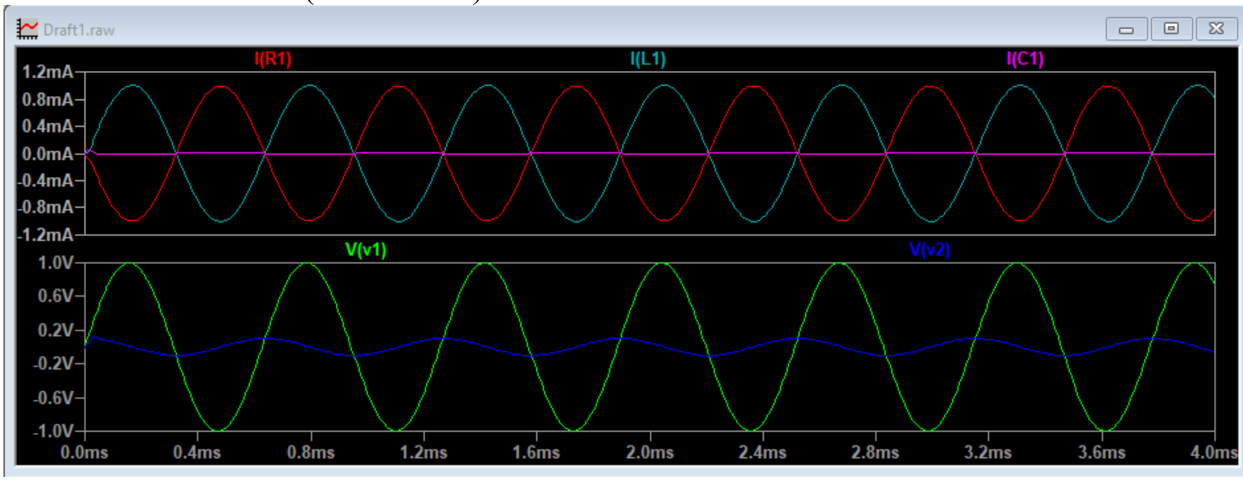
Figure 1b - A Parallel LC SPICE Circuit with a Sine Wave Source

Calculate the following reactances and impedances for the schematic 1a component values:

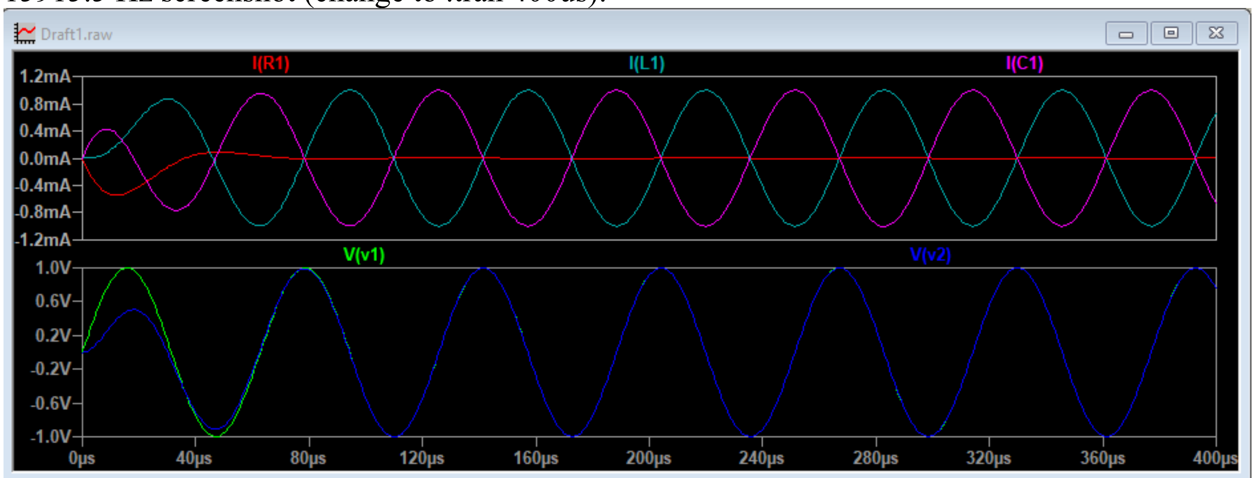
Frequency	R	X_L	X_C	X_{total} (Parallel X_C & X_L)	Z_{total}
1591.55 Hz	1k	100	-10k	101	1k + j101
15915.5 Hz	1k	1k	-1k	Undefined (/0)	Undefined
159155 Hz	1k	10k	-100	-101	1k – j101

Place screenshots of the simulation results of the 3 frequencies indicated in the table. In each simulation, display V(v1) and V(v2) in one plot pane, and I(R4), I(C5), I(L7) in a separate plot pane.

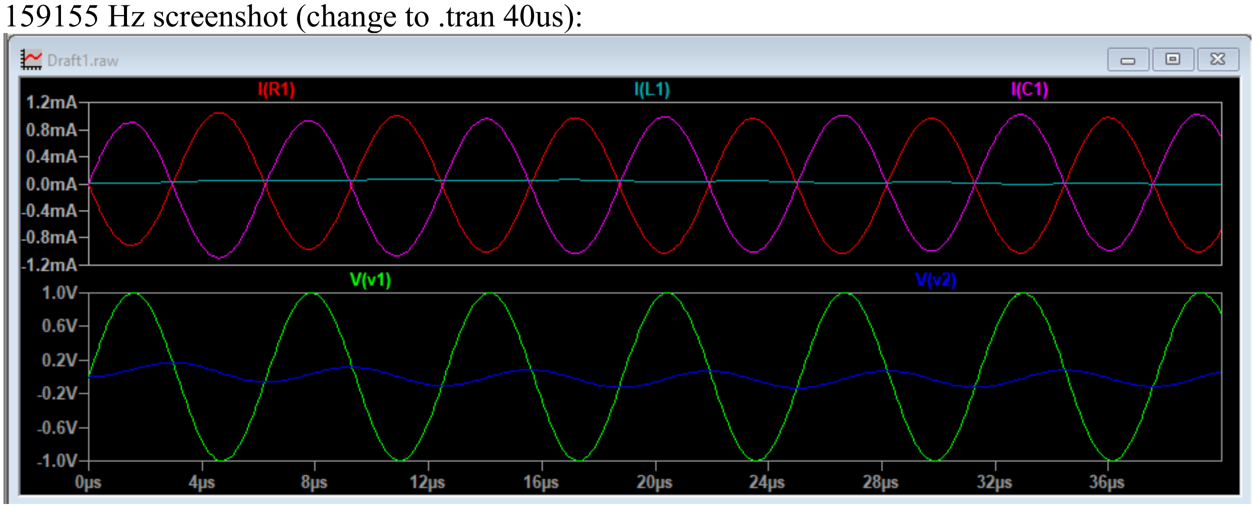
1591.55 Hz screenshot (.tran 4000us):



15915.5 Hz screenshot (change to .tran 400us):



159155 Hz screenshot (change to .tran 40us):



Section Summary

Can you make sense of these voltage and current waveforms based on the calculated reactances (explain)?

With a positive reactance, the capacitor current is 0 and while its negative the inductor current is 0. Volatges stay the same for if reactance is positive or negative but for when reactance is 0 (undefined) then the voltages are the same.

At what approximate point in time would you say the 15915.5 Hz signal reaches "steady-state"?

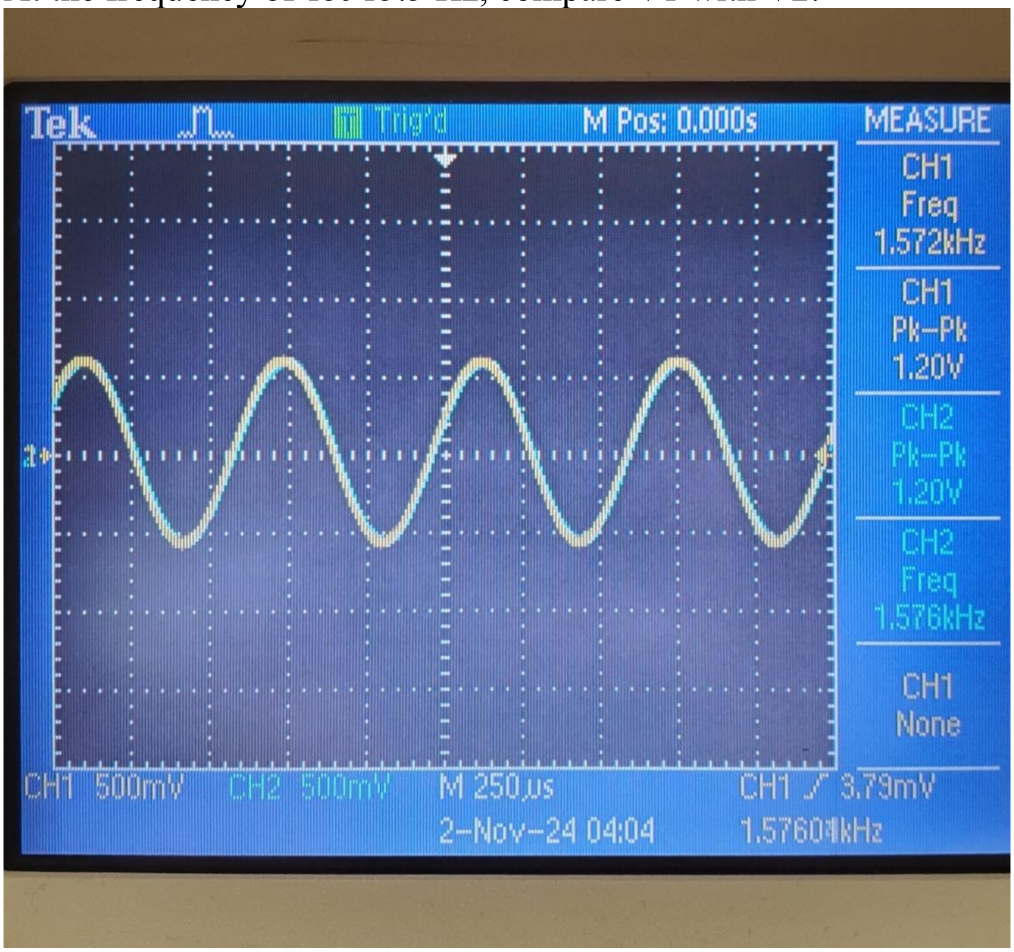
About 80us

Part 2a - Construct the physical series RLC circuit and make measurements

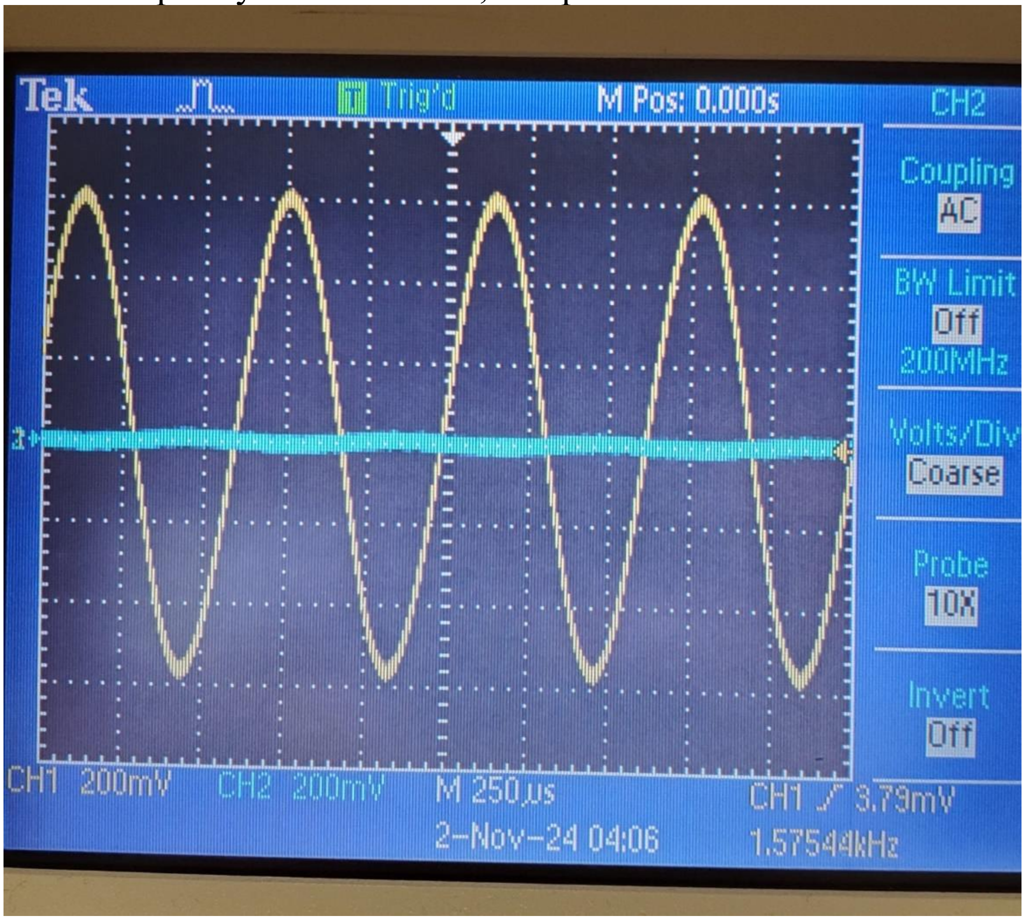
Construct the circuit of Part 1a and observe V1, V2 and V3 using lab equipment.

It is not necessary to include photos of all of the frequencies--only the center frequency. Please include the following photos:

At the frequency of 15915.5 Hz, compare V1 with V2:



At the frequency of 15915.5 Hz, compare V1 with V3:



Type equation here.

Using oscilloscope cursors, measure the phase difference between V1 and V3 with an input frequency of 15915.5 Hz.

Time difference: 300us
Phase difference in radians: π
Phase difference in degrees: 180º

Describe what happens on the V2 node when you sweep the function generator knob from approximately 1kHz to 100kHz (you might need to trigger on V1):

It follows V1, the higher the frequency the more scrunched up the waves get. With a low frequency they're long and slow. There is a small difference between V1 and V2, but that difference seems to stay the same as they both change

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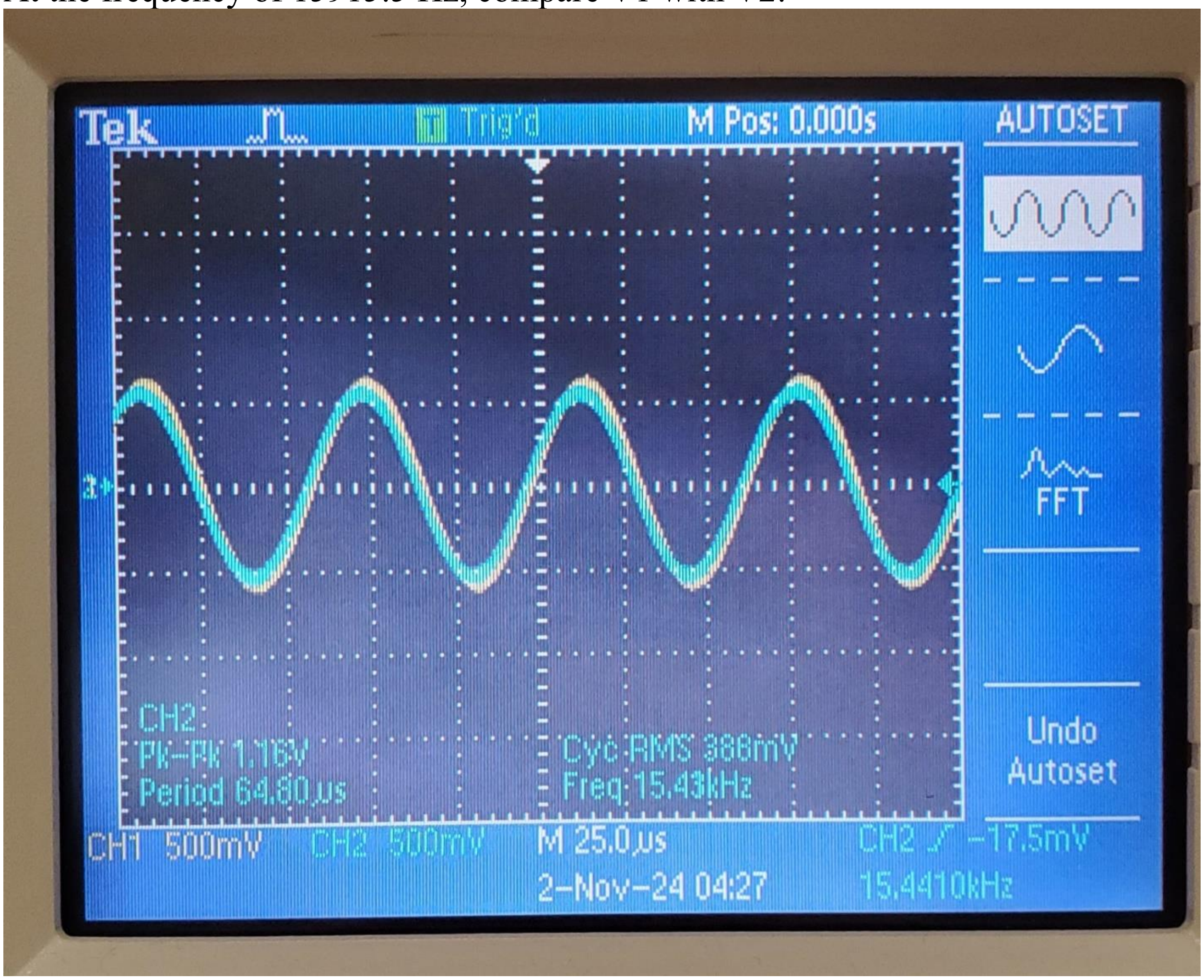
Part 2b - Construct the physical parallel RLC circuit and make measurements

Construct the circuit of Part 1b and observe V1 and V2 using lab equipment.

It is not necessary to include photos of all of the frequencies--only the center frequency. Please include the following photos:

At the frequency of 15915.5 Hz, compare V1 with V2:



Describe what happens on the V2 node when you sweep the function generator knob from approximately 1kHz to 100kHz (you might need to trigger on V1):

As you go up in frequency, V2 gets smaller because the reactance also got smaller as we went up in frequency. The inductor acts more and more like a short from V2 to ground as you go up so V2 gets closer and closer to 0.

Conclusions (write a conclusion statement that discusses each of the purposes of the lab):

In this lab, we observed the behaviors of inductors and capacitors using both simulations and by building a physical circuit and making measurements with the oscilloscope. We saw through both that at first they're changing but eventually steady out to a consistent oscillation. This is called the steady-state behavior after steadying out. We also saw how changing the frequency affected the voltages and the steady-state behavior.